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THE PRELIMINARY LONG DURATION EXPOSURE FACILITY (LDEF) MATERIALS DATA BASE

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INTRODUCTION

The Long Duration Exposure Facility (LDEF) Materials Special Investigation Group (MSIG) was charged with the task of establishing and developing an electronic data base which could eventually contain the wide variety and vast quantity of materials data being generated by the MSIG members and other LDEF investigators (ref. 1,2). Given the current and projected funding and manpower levels for the MSIG, it was determined that a pre-existing global-access data base system should serve as the host for the LDEF Materials Data Base. The Materials and Processes Technical Information System (MAPTIS) agreed to incorporate the LDEF Materials Data Base as part of their automated storage, retrieval and display data base system. The preliminary version of the LDEF Materials Data Base was released to the MAPTIS users in June of 1992 and is available to all interested parties in the International Space Materials Community. The goal of MAPTIS is to provide an efficient, reliable means of supplying the information needed for the selection and application of materials and processes to produce the hardware required for NASA's and industry's current and future space missions. MAPTIS uses an ORACLE Corporation's Relational Data Base Management System and can be accessed via a modem and a 1-800 phone number or via Telnet. Users can access MAPTIS using hardware that emulates a DEC VT100 terminal. There are several different data bases on the MAPTIS. A user and operations guide for the MAPTIS is available (ref. 3).

This paper describes the LDEF Materials Data Base and gives examples of some of the different search criteria available to the user. The paper also includes information on how to become an authorized user of the MAPTIS and thus the LDEF Materials Data Base.

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MAPTIS MAIN SCREENS

The main MAPTIS menu is a two screen menu shown in figure 1. The data on LDEF is contained in category 4 of the main menu. The sub-category "4A. Overview" is not operational at the current time. The second sub-category under the LDEF heading, "4B. Materials SIG data base", contains the preliminary LDEF Materials Data Base.

Standard Menu Options

As noted in figure 1, standard menu options for the MAPTIS may be seen by typing "DO" which returns a list of frequently used commands. These commands, listed in figure 2, allow the user to switch between 132 and 80 character formats, determine standard and metric units of measure, and "move around" in the MAPTIS system.

LDEF MATERIALS DATA BASE

Main Screen

After entering "4B" or "4b" from the main MAPTIS menu, the user is shown the main LDEF Materials Data Base menu, shown in figure 3. The main LDEF Materials Data Base menu is separated into seven major categories allowing the user to be specific or very general in the requested data search. The first major category, "1. Basic Data", contains the material's code, use type (i.e., paint, adhesive, etc.), composition, designation, minimum and maximum use temperature and/or any applicable industry, NASA or manufacturers specifications. The second major category, "2. All Data", displays all available data on any materials that are included in the data base and that meet the given search criteria which will be described in the following section. The third major category, "3. Data sources", allows the user to search for data by items specific to the source of the data. This includes such criteria as author, title of the paper, primary facility, etc. The fourth major category, "4. Electrical Properties", will eventually contain electrical property data such as surface resistivity, etc. However, at this time, this major category is inactive and contains no data. The fifth major category, "5. Mechanical Properties", contains mechanical property data and is separated into sub-categories as shown in figure 3. The specific mechanical property data or all mechanical property data can be requested. The mechanical property data which meet the user-specified search criteria will be returned. The sixth and seventh major categories, "6. General Properties" and "7. Optical/Thermal Properties", operate similarly to the fifth major category. The general properties category has sub-categories which include changes in mass and thickness, glass transition temperature, and volatile condensible material (VCM). Options "6D. Optical Density" and "6E. Surface Roughness " are not operational at this time. The seventh major category, "7. Optical/Thermal Properties", contains sub-categories such as absorptivity, emissivity, absorptivity/emissivity ratio, reflectance, transmittance, and coefficient of thermal expansion (CTE).

On-line help screens are available from most of the LDEF Materials Data Base screens, including the main screen, by typing an "H" followed by the option number of the feature for which the user is requesting help. The help screens show the information categories that are or will be listed under the specific option. A general help screen is also available by typing "H" from the main LDEF Materials Data Base menu. The general help screen, shown in figure 4, lists information specific to the LDEF Materials Data Base which the novice user may find helpful.

Basic Data Search

An example of a search using the Basic Data Search option along with the output from that search is described in the following section. As shown in figure 5, the help

screen for the basic data search screen, which is seen by typing "H1" at the main LDEF Materials Data Base menu, lists the type of information that is returned using the basic data search. At the main LDEF Materials Data Base menu (fig. 3) select option 1 and the LDEF Materials Data Base Basic Data Search Criteria screen, shown in figure 6, is displayed. At this point the user may choose up to three search criteria. The first optional criteria is "1. Material Code". The material code is a five digit number that is assigned by NASA Marshall Space Flight Center to identify a specific material, part, or assembly. The material code is the primary means of linking materials in the rest of the MAPTIS. At this time the majority of the entries in the LDEF Materials Data Base have not been given material codes and are not correlated to the rest of the MAPTIS. The second optional criteria is "2. Use type". The use type defines the actual use or application of the material. Possible use types currently available are adhesive, coating/paint, composite, film, mirror/reflector, miscellaneous, structural/cover plates/clamps, and thermal control blankets. The wildcard character, %, is available for use in the use type search criteria as well as in the other search criteria screens. For example, a search on "cover%" would return all use types starting with "cover". However, a search on "%cover%" would return all use types containing "cover". The third optional criteria is "3. Designation". The designation is the manufacturers identification or name for a product. Examples of designations include Chemglaze, and T300 graphite fibers/5208 epoxy. The fourth optional criteria is "4. Composition", which is the chemical or generic name of the material. Teflon and graphite fibers/epoxy are examples of composition listings. The fifth optional criteria is "5. Designation/Composition" which searches both the designation and composition fields and returns information on the materials that meet either criteria. This search criteria is specifically designed to allow the user to find the information requested without requiring the user to know the specific designation or composition. The sixth optional criteria is "6. Specification" which allows the user to search for a specific NASA, military or commercial specification. The seventh optional search criteria is "7. Manufacturer/Supplier" which allows the user to search for a specific manufacturer. For example, by searching on "%3m% the user would get a listing of all materials manufactured by 3M Corp. that are contained in the data base. The last optional search criteria is "8. Category (metals/non-metals)". This search criteria allows the user to search on metals, non-metals or both and is frequently used in conjunction with other search criteria.

As an example of a search, suppose the user wanted to know if there was any data in the data base on a composite material made from 934 epoxy resin. A basic data search using the fifth optional criteria, designation and composition, and using "%934%" would return any entry containing 934 in the designation or composition fields. The step-by-step screens with user required inputs shaded are shown in figure 7. The output from the aforementioned search is shown in figure 8. The output shows that data from a number of composites with 934 as the resin system are contained in the data base. The user may then request more specific information on a specific 934 composite. Also included in the output is any atomic concentration data that exists in the data base as shown in figure 8. The atomic concentration data are results of X-ray photoelectron spectroscopic (XPS) analyses. The first column is the specimen location on the LDEF.

The second column describes whether the specimen was coated, uncoated, covered or uncovered. The third through the ninth columns list the percentage of atomic concentration of a specific element in the first 5 nanometers of the surface. The data source or reference is noted in the last column of the table under the heading DS for data source. In the example shown in figure 8, data from two sources, data source numbers 1032 and 1035, are listed. Currently the user is required to go to the data source option of the data base and query on the data source numbers to determine what the reference is for the atomic concentration data. In the near future the data source listed in the atomic concentration data tables will be listed at the conclusion of the query as is currently done for other data source listings. For completeness the data in the atomic concentration table are from two papers published in *LDEF Materials Workshop '91*, NASA Conference Publication 3162. Data source 1032 is reference 4 and data source 1035 is reference 5.

Specific Property Searches

Options 2, and 4 through 7 of the main LDEF Materials Data Base menu(fig. 3) all deal with properties of the material and all have the same search criteria. The search criteria screen for these options is shown in figure 9. Options 1 through 8 have been previously described in the basic data search criteria. Option "9. Location" allows the user to search by specific location on the LDEF. For example if the user was interested in the leading edge only, the user could search on the location row 9 and would input "%9%" at the location prompt. Option "10. Experiment Number" allows the user to search on up to three specific experiment numbers. Option "11. E (eV) Value" allows the user to search on materials which meet a given range of energy of atomic oxygen. Options "12. Est. Sun Hours", "13. AO Flux Values", and "14. Angle of Incidence Values" also allow the user to search on a range of numerical values. In this case the values are estimated sun hours, atomic oxygen flux, and angle of incidence of the atomic oxygen, respectively. The last option, "15. Data Sources" is discussed in the next section.

As an example, suppose the user wants to search on all of the absorptivity data on T300/934 composites that received more than 9E13 atoms/cm^{2}s of atomic oxygen. The user would select option number "7B" from the main LDEF Materials Data Base menu which specifies absorptivity data as shown in figure 10. Then the user would select options "5,13" from the LDEF Materials Data Base search criteria menu. At the designation/composition screen the user would be prompted to enter "%T300%934%". The user would then been prompted to enter the values of atomic oxygen required. In this example, the user would then enter ">" and "9E13". The data base then would return the output shown in figure 11. The atomic concentration data was discussed in the previous section. Two data sets are listed. Both are from the same location, experiment and data source. The output lists the test apparatus used to conduct the test, the pre- and post-flight measurements and , in this case, the side of the material being measured. Immediately following the data listing is a list of the data source. The data source output correlates the data with the title, and author(s) of the published paper containing the original data. Currently all data in the data base are from a published paper.

However, in the future, the data base will contain unpublished data which will be correlated by primary facility and principal investigator(s).

Data Source Searches

The last type of search available from the main LDEF Materials Data Base screen is the data sources search. Option "3. Data Sources" from the main screen allows the user to search by data source number, primary facility, author or document title. For example, if the user wanted to know all the papers from which data were extracted for the data base by a specific author, the user would follow the steps shown in figure 12. First, option "3. Data Sources" would be chosen from the main screen. Second, since the user wanted to know about data sources written by a specific author, the user would choose option "3. Author or Secondary Facility" from the LDEF Materials Data Base Data Source Search Criteria. At the prompt the user would input the author's name. Using the wildcard character in front and behind the author's name, for example "%pippin%" assures that all data sources containing the author's name will be listed. The output from this search is shown in figure 13.

CHANGES TO THE LDEF MATERIALS DATA BASE

As stated in the introduction of this paper, the LDEF Materials Data Base is a preliminary version of this data base. The data base has and will continue to change and grow as more information becomes available. During the Second LDEF Post-Retrieval Symposium, a group of industry and government advisors met. This advisory group, called the LDEF Materials Data Base Format Committee, was given the goal of critiquing the initial format and content of the data base to ensure that it would develop into a valuable tool for both the space researcher and the spacecraft designer. A listing of the committee members is shown in figure 14. The committee's input has guided the changes that the data base is currently undergoing. These changes include adding atomic oxygen fluence data and in general, adding features to aid the novice user.

ACCESS TO THE DATA BASE

As previously stated, the LDEF Materials Data Base is a part of the MAPTIS. For those parties interested in accessing the LDEF Materials Data Base and thus MAPTIS, a form, figure 15, is included in this paper. By filling out the form and returning it to the fax number listed on the bottom of the form, the requestor will be given a user identification name and password to the MAPTIS. Users are requested to send their comments and suggestions to the people listed on the LDEF Materials Data Base attention screen which is displayed each time a user accesses the data base.

ADDITIONS TO THE DATA BASE

The developers of the LDEF Materials Data Base are currently acquiring additional data to incorporate into the data base. One of the purposes of the LDEF Materials Data Base is to collect and disseminate unpublished data so that valuable LDEF data will not be lost to future designers and researchers. Researchers having data they would like to have incorporated into the LDEF Materials Data Base are asked to contact the first author of this paper.

CONCLUDING REMARKS

The Materials Special Investigation Group of LDEF has developed the LDEF Materials Data Base on MAPTIS. The LDEF Materials Data Base is an electronic data base which users can access remotely. Although preliminary in nature, the LDEF Materials Data Base is designed to eventually contain the vast quantity of materials data generated from the 5.8-year flight of the Long Duration Exposure Facility.

REFERENCES

1. Stein, Bland A.: "An Interim Overview of LDEF Materials Findings", NASA TM-107664, August 1992.

2. Levine, Arlene S.: *LDEF- 69 Months In Space: First Post-Retrieval Symposium*, NASA CP-3134, June 1991.

3. User and Operations Guide For the Marshall Space Flight Center Materials and Processes Technical Information System (MAPTIS), available from NASA- MSFC, Mail Code EH02, Huntsville, AL 35812, Jan. 1992.

4. Young, Philip R.; and Slemp, Wayne S.: "Characterization of Selected LDEF-Exposed Polymeric Films and Resins," *LDEF Materials Workshop '91*, NASA CP-3162, Part 1, Nov. 19-22, 1991.

5. Tennyson, R. C. : "Additional Results On Space Environmental Effects on Polymer Matrix Composites- Experiment AO180", *LDEF Materials Workshop '91*, NASA CP-3162, Part 2, Nov. 19-22, 1991, pp. 571-592.

CHOICE: MAPTIS - MAIN MENU Page 1 of 2
PRESS RETURN FOR NEXT PAGE

1. MECHANICAL/PHYSICAL PROPERTIES
   A. Metals
   B. Nonmetals
   C. Acoustics
   D. Atomic Oxygen
   D. Atomic Oxygen
   E. Magnetic Materials
   F. High Temperature
   G. Bondline Information System
   H. Nozzles Materials

2. MATERIAL SELECTION
   A. Metals (MSFC-SPEC-522, etc)
   B. Nonmetals (NHB 8060.1, etc)
   C. Standard/Commercial Parts

3. VERIFICATION & CONTROL
   A. MUA - Mtrl Usage Agreements
   B. Foreign Alloy Cross Reference
   C. MIUL - Mtrl Id and Usage List
   D. Intercenter Agreement Cert. Letter
   D. Intercenter Agreement Cert. Letters

4. LONG DURATION EXPOSURE FACILITY DATA
   A. Overview
   B. Materials SIG Data

5. FAILURE ANALYSIS

6. (NOET) INFORMATION SYSTEM (NSI)
   A. Replacement Technology
   B. Propulsion Technology (TBD)

CHOICE: ENTER NUMBER & ALPHA (1C GETS THE ACOUSTICS DATABASE)
FOR HELP: ENTER H PRIOR TO CHOICE (H1C GETS HELP FOR ACOUSTICS DATABASE)
NOTE: ENTER DO FOR LIST OF STANDARD MENU OPTIONS

CHOICE: _____ MAPTIS - MAIN MENU Page 2 of 2
PRESS RETURN FOR PREVIOUS PAGE

7. MANAGEMENT SYSTEMS FOR PROJECTS
   A. SSF - Space Station Freedom II
   B. NLS - National Launch System

8. SPECIFICATIONS AND STANDARDS

9. ADMINISTRATIVE
   A. MSFC Form 512.5
   B. MSFC Form 424

CHOICE: ENTER NUMBER & ALPHA (1C GETS THE ACOUSTICS DATABASE)
FOR HELP: ENTER H PRIOR TO CHOICE (H1C GETS HELP FOR ACOUSTICS DATABASE)
NOTE: ENTER DO FOR LIST OF STANDARD MENU OPTIONS

Figure 1. MAPTIS main screens.

CHOICE: _____ MAPTIS - STANDARD MENU OPTIONS

OPTION	ACTION
0 /PM	Previous Menu
97/MM	Main Menu
98/CM	Change menu display from full to brief or brief to full.
99/LO	Log off the MAPTIS VAX
AM	Activate the Action Menu
BB	Display Bulletin Board
BO	Toggle between running queries online (default) & batch.
CF	Toggle report format between 132 (default) & 80.
CU	Toggle report unit of measure between standard (def) & metric
CQ	Change action mode to Canned Query.
DF	Display report format selection.
TIME	Display the Date and Time
PHONE	Activate the VAX Phone Utility
MAIL	Activate the VAX Mail Utility

OPTION	ACTION
DO	Display this list of menu options
DU	Display report unit of measure selection.
ID	Change your Query ID
PW	Allow user to change their VAX Password.
SF	Activate System Functions Menu

**NOTE: FOR NONMETALS MATERIAL SELECTION TEST REPORT DATA QUERIES ONLY

EXPERT	Turns off NOVICE Function
NOVICE	Automatic material count/screen at time scroll
MC	Material count prior to query report generation
SS	Scroll query report screen at a time
DN	Display NOVICE Functions

Figure 2. Standard menu options for MAPTIS.

CHOICE: _____ MAPTIS - LDEF MATERIALS DATABASE

1. Basic Data
2. All Data
3. Data sources

4. Electrical Properties
   A. Surface Resistance

5. Mechanical Properties
   A. All Mechanical Properties
   B. Elastic Modulus
   C. Tensile Strength
   D. Hardness
   E. Maximum Load
   F. Shear
   G. Flexural
   I. Compression Strength
   J. Load Deflection

6. General Properties
   A. All General Properties
   B. Change in Mass
   C. Change in Thickness
   D. Optical Density
   E. Surface Roughness
   F. Glass Transition Temperature
   G. VCM

7. Optical/Thermal Properties
   A. All Optical/Thermal Properties
   B. Absorptivity
   C. Emissivity
   D. Absorptivity/ Emissivity
   E. Reflectance
   F. Transmittance
   G. Coeff. Thermal Expansion

CHOICE: ENTER UP TO 3 CHOICES DELIMIT WITH A COMMA (5C,6A,7D)
FOR HELP: ENTER H FOR GENERAL HELP OR H AND CHOICE FOR MORE SPECIFIC HELP (H7B)
NOTE: ENTER DO TO LIST STANDARD MENU OPTIONS

Figure 3. The LDEF Materials Data Base main menu screen.

MAPTIS - LDEF MATERIALS DATA BASE GENERAL HELP

VCM - this data found in the data base is defined as Volatile Condensible Materials according to the paper(s) from which the data has been taken.

When a query is run on the system, any data that is available that meets your search criteria will scroll across the screen as it is being retrieved and when the query is complete, you will receive a "Query Complete" message. If you receive a "Query Complete" message without seeing any data, this means that there is no data currently in the system that meets your given search criteria.

The convention used for naming and describing all composites in this data base is fibers first, followed by matrix material (example: GY70 graphite fibers/934 epoxy, SP288 graphite fibers/V108 epoxy, etc...)

In this data base and throughout MAPTIS, Designation refers to the manufacturer's designation or name for a given material or the commonly refered to trade name (i.e., KAPTON, GY70 graphite fibers, etc...). Composition refers to the "generic" composition of a given material (i.e., polyimide, graphite, PTFE, FEP, etc...).

PRESS RETURN TO CONTINUE:

Figure 4. The LDEF Materials Data Base general help screen.

MAPTIS - LDEF MATERIALS DATABASE HELP

BASIC DATA - is the general information about the material being returned.

This data includes:

MATERIAL CODE	- NASA assigned material identifier
DESIGNATION	- Manufacturers' product identification
COMPOSITION	- Generic material makeup
USE TEMPERATURE	- Recommended temperature range for the product
USE TYPE	- Generic use of the material *Example: Adhesive, Coating
REMARKS	- Other information relating to the material
SPECIFICATION	- Specifications pertaining to the material
MANUFACTURER/ SUPPLIER	- Company that makes and/or supplies the material
ADDRESS	- Address of manufacturer/supplier

ATOMIC CONCENTRATION data will also be provided when available.

NOTE: BASIC DATA will be slightly different for metallic materials.

Figure 5. The LDEF Materials Data Base basic data help screen.

CHOICE: _____ LDEF MATERIALS DATABASE BASIC DATA SEARCH CRITERIA

1. Material Code
2. Use Type
3. Designation
4. Composition
5. Designation / Composition
6. Specification
7. Manufacturer / Supplier
8. Category (metals / non-metals)

CHOICE: ENTER UP TO 3 SEARCH CRITERIAS DELIMIT WITH A COMMA (2,5,6)
FOR HELP: ENTER H PRIOR TO ANY CHOICE (H1 GETS HELP ON DESIGNATION)
NOTE: ENTER DO TO LIST STANDARD MENU OPTIONS

Figure 6. The LDEF Materials Data Base basic data search screen.

CHOICE: 1

MAPTIS - LDEF MATERIALS DATABASE

1. Basic Data
2. All Data
3. Data sources

4. Electrical Properties
   A. Surface Resistance

5. Mechanical Properties
   A. All Mechanical Properties
   B. Elastic Modulus
   C. Tensile Strength
   D. Hardness
   E. Maximum Load
   F. Shear
   G. Flexural
   I. Compression Strength
   J. Load Deflection

6. General Properties
   A. All General Properties
   B. Change in Mass
   C. Change in Thickness
   D. Optical Density
   E. Surface Roughness
   F. Glass Transition Temperature
   G. VCM

7. Optical/Thermal Properties
   A. All Optical/Thermal Properties
   B. Absorptivity
   C. Emissivity
   D. Absorptivity/ Emissivity
   E. Reflectance
   F. Transmittance
   G. Coeff. Thermal Expansion

CHOICE: ENTER UP TO 3 CHOICES DELIMIT WITH A COMMA (5C,6A,7D)
FOR HELP: ENTER H FOR GENERAL HELP OR H AND CHOICE FOR MORE SPECIFIC HELP (H7B)
NOTE: ENTER DO TO LIST STANDARD MENU OPTIONS

CHOICE: 5

LDEF MATERIALS DATABASE BASIC DATA SEARCH CRITERIA

1. Material Code
2. Use Type
3. Designation
4. Composition
5. Designation / Composition
6. Specification
7. Manufacturer / Supplier
8. Category (metals / non-metals)

CHOICE: ENTER UP TO 3 SEARCH CRITERIAS DELIMIT WITH A COMMA (2,5,6)
FOR HELP: ENTER H PRIOR TO ANY CHOICE (H1 GETS HELP ON DESIGNATION)
NOTE: ENTER DO TO LIST STANDARD MENU OPTIONS

Enter up to three designations

You must supply all wildcards (%). Enter <CR> to terminate entry.

%934% KEVLAR%

MYLAR%

%ALUMINUM%

Figure 7. Example input for basic data search on 934 resin system.

```
                    PROCESSING YOUR QUERY

          IF YOU MUST EXIT QUERY BEFORE IT HAS FINISHED PROCESSING

          PRESS CTRL & C KEYS SIMULTANEOUS ONE TIME (MAY TAKE FEW SECONDS)


          CTRL-Y(s) AND MULTIPLE CTRL-Cs WILL BACK YOU UP TO SOME
          PREVIOUS MENU AND MAY POSSIBLY LOG YOU OFF THE SYSTEM IF
          TOO MANY ARE ENTERED.

*************** MAPTIS - LDEF MATERIALS DATABASE *********************************

MATERIAL CODE:

     USE TYPE:  COMPOSITE

  DESIGNATION:  HMS 934

  COMPOSITION:  GRAPHITE FIBERS/EPOXY

 USE TEMP MIN:                  USE TEMP MAX:

      REMARKS:

SPECIFICATION:

*************** MAPTIS - LDEF MATERIALS DATABASE *********************************

MATERIAL CODE:
     USE TYPE:  COMPOSITE

  DESIGNATION:  P75S/934

  COMPOSITION:  GRAPHITE FIBERS/EPOXY

 USE TEMP MIN:                  USE TEMP MAX:


*************** MAPTIS - LDEF MATERIALS DATABASE *********************************

MATERIAL CODE:

     USE TYPE:  COMPOSITE

  DESIGNATION:  ALUMINUM HONEYCOMB (4.40 AG5) WITH CFRP FACE SHEETS OF GY70
                FIBERS/934 EPOXY,AND BSL 312 BOND FILM

  COMPOSITION:  ALUMINUM 4.40 AG5, FIBER/EPOXY, AND  OND FILM

 USE TEMP MIN:                  USE TEMP MAX:

      REMARKS:

SPECIFICATION:


*************** MAPTIS - LDEF MATERIALS DATABASE *********************************

MATERIAL CODE:

     USE TYPE:  COMPOSITE

  DESIGNATION:  GY70 FIBERS/934 EPOXY, UNIDIRECTIONAL, RECTANGULAR TUBE

  COMPOSITION:  FIBERS/EPOXY

 USE TEMP MIN:                  USE TEMP MAX:

      REMARKS:


SPECIFICATION:
```

Figure 8. Screen output for basic data search on 934 resin.

```
********** MAPTIS - LDEF MATERIALS DATABASE **********

MATERIAL CODE:
     USE TYPE:  COMPOSITE
  DESIGNATION:  GY70 FIBERS/934 EPOXY, UNIDIRECTIONAL
  COMPOSITION:  FIBER/EPOXY
 USE TEMP MIN:                  USE TEMP MAX:
      REMARKS:

SPECIFICATION:


     SUPPLIER:  FIBERITE
     DIVISION:
      ADDRESS:
         CITY:      STATE:     COUNTRY:

********** MAPTIS - LDEF MATERIALS DATABASE **********

MATERIAL CODE:
     USE TYPE:  COMPOSITE
  DESIGNATION:
  COMPOSITION:  T300 GRAPHITE/934 EPOXY
 USE TEMP MIN:                  USE TEMP MAX:
      REMARKS:

SPECIFICATION:


ATOMIC CONCENTRATION DATA
```

LOCATION	MATERIAL SIDE	C	CL	CU	F	NA	O	SI	DS
B9	EXPOSED SIDE,NO COAT	54.3					33.0	7.5	1032
B9	COVERED SIDE,NO COAT	62.8			2.0	1.7	24.8	3.4	1032
B9	EXPOSED SIDE,COATED	28.9					47.6	11.8	1032
B9	COVERED SIDE, COATED	65.1					29.7	2.4	1032
D12, #1	EXPOSED SIDE	49.7				0.5	34.0	13.0	1035
D12, #1	UNEXPOSED SIDE	66.1				0.40	23.3	3.60	1035
D12, #2	EXPOSED SIDE	52.7				1.70	32.1	11.8	1035
D12, #2	UNEXPOSED SIDE	64.5				0.50	25.7	4.30	1035

```
Query complete - press return to continue:
```

Figure 8 (concluded). Screen output for basic data search on 934 resin.

CHOICE: _____ LDEF MATERIALS DATABASE ALL DATA SEARCH CRITERIA

1. Material Code
2. Use Type
3. Designation
4. Composition
5. Designation / Composition
6. Specification
7. Manufacturer / Supplier
8. Category (metals / non-metals)
9. Location
10. Experiment Number
11. E (eV) value
12. Est. Sun Hours
13. AO Flux value
14. Angle of Incidence value
15. DATA SOURCES
    A. Data Source Number
    B. Primary Facility
    C. Author or Secondary Facility
    D. Document Title

CHOICE: ENTER UP TO 3 SEARCH CRITERIAS DELIMIT WITH A COMMA (2,5,6)
FOR HELP: ENTER H PRIOR TO ANY CHOICE (H1 GETS HELP ON DESIGNATION)
NOTE: ENTER DO TO LIST STANDARD MENU OPTIONS

Figure 9. The LDEF Materials Data Base all data search screen.

CHOICE: 7B

MAPTIS - LDEF MATERIALS DATABASE

1. Basic Data
2. All Data
3. Data sources

4. Electrical Properties
   A. Surface Resistance

5. Mechanical Properties
   A. All Mechanical Properties
   B. Elastic Modulus
   C. Tensile Strength
   D. Hardness
   E. Maximum Load
   F. Shear
   G. Flexural
   I. Compression Strength
   J. Load Deflection

6. General Properties
   A. All General Properties
   B. Change in Mass
   C. Change in Thickness
   D. Optical Density
   E. Surface Roughness
   F. Glass Transition Temperature
   G. VCM

7. Optical/Thermal Properties
   A. All Optical/Thermal Properties
   B. Absorptivity
   C. Emissivity
   D. Absorptivity/ Emissivity
   E. Reflectance
   F. Transmittance
   G. Coeff. Thermal Expansion

CHOICE: ENTER UP TO 3 CHOICES DELIMIT WITH A COMMA (5C,6A,7D)
FOR HELP: ENTER H FOR GENERAL HELP OR H AND CHOICE FOR MORE SPECIFIC HELP (H7B)
NOTE: ENTER DO TO LIST STANDARD MENU OPTIONS

CHOICE: 5,13

LDEF MATERIALS DATABASE ALL DATA SEARCH CRITERIA

1. Material Code
2. Use Type
3. Designation
4. Composition
5. Designation / Composition
6. Specification
7. Manufacturer / Supplier
8. Category (metals / non-metals)
9. Location
10. Experiment Number
11. E (eV) value
12. Est. Sun Hours
13. AO Flux value
14. Angle of Incidence value
15. DATA SOURCES
    A. Data Source Number
    B. Primary Facility
    C. Author or Secondary Facility
    D. Document Title

CHOICE: ENTER UP TO 3 SEARCH CRITERIAS DELIMIT WITH A COMMA (2,5,6)
FOR HELP: ENTER H PRIOR TO ANY CHOICE (H1 GETS HELP ON DESIGNATION)
NOTE: ENTER DO TO LIST STANDARD MENU OPTIONS

Enter up to three designations

You must supply all wildcards (%).

%T300%934%

Enter <CR> to terminate entry.

KEVLAR%

MYLAR%

%ALUMINUM%

Do you want the value in AO Flux to be (=, NOT=, <, <=, >, >=)

>

Enter value for AO Flux

9E13 (atom/sq.cm*s)

Figure 10. Input screens for example search for absorptivity data on T300/934 exposed to atomic oxygen flux greater than 9E13 atoms/cm^{2}s.

PROCESSING YOUR QUERY

IF YOU MUST EXIT QUERY BEFORE IT HAS FINISHED PROCESSING

PRESS CTRL & C KEYS SIMULTANEOUS ONE TIME (MAY TAKE FEW SECONDS)

CTRL-Y(s) AND MULTIPLE CTRL-Cs WILL BACK YOU UP TO SOME PREVIOUS MENU AND MAY POSSIBLY LOG YOU OFF THE SYSTEM IF TOO MANY ARE ENTERED.

******* MAPTIS - LDEF MATERIALS DATABASE ********************************** 31-AUG-92

MATERIAL CODE:
USE TYPE: COMPOSITE
MANUF DESIGNATION:
COMPOSITION: T300 GRAPHITE/934 EPOXY
USE TEMP MIN: USE TEMP MAX:
REMARKS:
SPECIFICATION:

MANUF/SUPP:
DIVISION:
ADDRESS:
CITY: STATE:
COUNTRY:

ATOMIC CONCENTRATION DATA

LOCATION	MATERIAL SIDE	C	CL	CU	F	NA	O	SI	DS #
B9	EXPOSED SIDE,NO COAT	54.3					33.0	7.5	1032
B9	COVERED SIDE,NO COAT	62.8			2.0	1.7	24.8	3.4	1032
B9	EXPOSED SIDE,COATED	28.9					47.6	11.8	1032
B9	COVERED SIDE, COATED	65.1					29.7	2.4	1032
D12, #1	EXPOSED SIDE	49.7				0.5	34.0	13.0	1035
D12, #1	UNEXPOSED SIDE	66.1				0.40	23.3	3.60	1035
D12, #2	EXPOSED SIDE	52.7				1.70	32.1	11.8	1035
D12, #2	UNEXPOSED SIDE	64.5				0.50	25.7	4.30	1035

Figure 11. Output from example search in figure 10.

```
OPTICAL / THERMAL PROPERTY EFFECTS DATA

PROPERTY NAME: ABSORPTIVITY                          QUALIFIER: SOLAR
      PRE-FLT: 0.90        POST-FLT: 0.90              UNITS:
MATERIAL SIDE: UNEXPOSED SIDE                        LOCATION: D9
    SUBSTRATE:                                    EXPERIMENT #: M0003-8
TST WAVELNGTH:                                    SAMPLE THICK:
TST APPARATUS: PERKIN-ELMER LAMBDA 9 USED PER ASTM E424A
  SAMPLE TEMP:                                  EXPOSURE TIME: 5.77 (yrs)
 EST. SUN HRS: 11100                             A-O FLUX AOI: 82 (deg)
         FLUX:   9.16E+13 (atom/cm2*s)                    E: 5 (eV)
  A-O FLUENCE:
    COMMENT #:                                         DS #: 1015

------
------

PROPERTY NAME: ABSORPTIVITY                          QUALIFIER: SOLAR
      PRE-FLT: 0.90        POST-FLT: 0.93              UNITS:
MATERIAL SIDE: EXPOSED SIDE                          LOCATION: D9
    SUBSTRATE:                                    EXPERIMENT #: M0003-8
TST WAVELNGTH:                                    SAMPLE THICK:
TST APPARATUS: PERKIN-ELMER LAMBDA 9 USED PER ASTM E424A
  SAMPLE TEMP:                                  EXPOSURE TIME: 5.77 (yrs)
 EST. SUN HRS: 11100                             A-O FLUX AOI: 82 (deg)
         FLUX:   9.16E+13 (atom/cm2*s)                    E: 5 (eV)
  A-O FLUENCE:
    COMMENT #:                                         DS #: 1015

------
------

DATA SOURCE

   DATA SOURCE:  1015          DATE:  30-JUN-91
      FACILITY:  BOEING DEFENSE AND SPACE GROUP
 DOCUMENT TYPE:  TECHNICAL PAPER PRESENTED AT LDEF SYMPOSIUM, JUNE 1991
IDENTIFICATION:  CP-3134, PART 2
         TITLE:  RESULTS FROM ANALYSIS OF BOEING COMPOSITE SPECIMENS FLOWN ON
                 LDEF EXPERIMENT M0003
        REMARK:  PETE E. GEORGE, SYLVESTER G. HILL
Query complete - press return to continue:
```

Figure 11 (concluded). Output from example search in figure 10.

CHOICE: 3 MAPTIS - LDEF MATERIALS DATABASE

1. Basic Data
2. All Data
3. Data sources

4. Electrical Properties
   A. Surface Resistance

5. Mechanical Properties
   A. All Mechanical Properties
   B. Elastic Modulus
   C. Tensile Strength
   D. Hardness
   E. Maximum Load
   F. Shear
   G. Flexural
   I. Compression Strength
   J. Load Deflection

6. General Properties
   A. All General Properties
   B. Change in Mass
   C. Change in Thickness
   D. Optical Density
   E. Surface Roughness
   F. Glass Transition Temperature
   G. VCM

7. Optical/Thermal Properties
   A. All Optical/Thermal Properties
   B. Absorptivity
   C. Emissivity
   D. Absorptivity/ Emissivity
   E. Reflectance
   F. Transmittance
   G. Coeff. Thermal Expansion

CHOICE: ENTER UP TO 3 CHOICES DELIMIT WITH A COMMA (5C,6A,7D)
FOR HELP: ENTER H FOR GENERAL HELP OR H AND CHOICE FOR MORE SPECIFIC HELP (H7B)
NOTE: ENTER DO TO LIST STANDARD MENU OPTIONS

CHOICE: 3 LDEF MATERIALS DATABASE DATA SOURCE SEARCH CRITERIA

1. Data Source Number
2. Primary Facility
3. Author or Secondary Facility
4. Document Title

CHOICE: ENTER UP TO 3 SEARCH CRITERIAS DELIMIT WITH A COMMA (1,2,4)
FOR HELP: ENTER H PRIOR TO ANY CHOICE (H1 GETS HELP ON DESIGNATION)
NOTE: ENTER DO TO LIST STANDARD MENU OPTIONS

Enter up to three AUTHORS or SECONDARY FACILITIES

You must supply all wildcards (%)!! Enter <CR> to terminate entry.

%pippin% %MULKEY%

%RUTLEDGE%

%UNIVERSITY%

Figure 12. Input screens for example screen on data sources by author named Pippin.

```
IF YOU MUST EXIT QUERY BEFORE IT HAS FINISHED PROCESSING

PRESS CTRL & C KEYS SIMULTANEOUS ONE TIME (MAY TAKE FEW SECONDS)


CTRL-Y(s) AND MULTIPLE CTRL-Cs WILL BACK YOU UP TO SOME
PREVIOUS MENU AND MAY POSSIBLY LOG YOU OFF THE SYSTEM IF
TOO MANY ARE ENTERED.


DATA SOURCE

   DATA SOURCE:  1001          DATE:  30-JUN-91
       FACILITY:  NASA, LANGLEY RESEARCH CENTER
  DOCUMENT TYPE:  TECHNICAL PAPER PRESENTED AT LDEF SYMPOSIUM, JUNE 1991
 IDENTIFICATION:  CP-3134, PART 2
          TITLE:  PRELIMINARY FINDINGS OF THE LONG DURATION EXPOSURE FACILITY
                  MATERIALS SPECIAL INVESTIGATION GROUP
         REMARK:  BLAND A. STEIN; BOEING DEFENSE AND SPACE GROUP, H. GARY
                  PIPPIN

   DATA SOURCE:  1005          DATE:  30-JUN-91
       FACILITY:  BOEING AEROSPACE AND ELECTRONICS DIVISION
  DOCUMENT TYPE:  TECHNICAL PAPER PRESENTED AT LDEF SYMPOSIUM, JUNE 1991
 IDENTIFICATION:  CP-3134, PART 2
          TITLE:  RESULTS OF EXAMINATION OF SILVERED TEFLON FROM THE LONG
                  DURATION EXPOSURE FACILITY
         REMARK:  KEN ROUSSLANG, RUSS CRUTCHER, GARY PIPPIN

   DATA SOURCE:  1014          DATE:  30-JUN-91
       FACILITY:  BOEING DEFENSE AND SPACE GROUP
  DOCUMENT TYPE:  TECHNICAL PAPER PRESENTED AT LDEF SYMPOSIUM, JUNE 1991
 IDENTIFICATION:  CP-3134, PART 2
          TITLE:  SURVEY OF RESULTS FROM THE BOEING MODULES ON THE M0003
                  EXPERIMENT ON LDEF
         REMARK:  H. G. PIPPIN, OWEN MULKEY, JURIS VERZEMNIEKS, EMMETT MILLER,
                  SYLVESTER HILL, HARY DURSCH

   DATA SOURCE:  1037          DATE:  30-NOV-91
       FACILITY:  EUROPEAN SPACE AGENCY, ESTEC
  DOCUMENT TYPE:  TECHNICAL PAPER PRESENTED AT LDEF MATERIALS WORKSHOP, NOV 91
 IDENTIFICATION:
          TITLE:  EFFECTS OF THE LDEF ENVIRONMENT ON THE SILVER/FEP THERMAL
                  BLANKETS
         REMARK:  FRANCOIS LEVADOU; BOEING DEFENSE AND SPACE GROUP, GARY
                  PIPPIN


Query complete - press return to continue:
```

Figure 13. Output from example search in figure 12 on a specific author.

LDEF Materials Data Base Format Committee

Chairman: Joan Funk
NASA- Langley Research Center

Co-Chairman: John Davis
NASA-Marshall Space Flight Center

Kaia David
McDonnell Douglas SSC

Bruce Drolen
Hughes Aircraft, Space
& Communications Group

James Gehen
McDonnell Douglas SSC

Dave Harden
Boeing

William T. Lee
Rocketdyne

Ray LeVesque
McDonnell Douglas SSC

Steve McKinney
Space Systems/Loral

Glenn G. Ormbrek
Wright Labs/MLB

Brian Petrie
Lockheed Missiles & Space Co.

Dr. Lou Rosales
TRW

Bland Stein
NASA-Langley Research Center

John Strickland
BAMSI Inc.

Wayne Stuckey
The Aerospace Corporation

Alan Tribble
Rockwell International
Space Systems Div.

Figure 14. Members of the LDEF Materials Data Base Format Committee.